Internal Vibrator Provided with a Liberation Device

The present invention relates to an internal vibrator device according to the preamble of independent Claim 1, and to a method for freeing a jammed internal vibrator device according to the preamble of independent Claim 11.

Internal vibrator devices, also known as internal vibrators, are generally known and are used to compact liquid concrete. For this purpose, at the end of a longer or shorter hose -- corresponding to a hose or bar vibrator -- a vibrator bottle is attached that houses an electric motor and an imbalance mass or imbalance device driven by this motor. The imbalance mass, which rotates at a very high speed, produces a vibration matched to the concrete that is to be compacted; after the vibrator bottle is immersed in the fresh concrete, this vibration is transmitted to the concrete, removing air pockets and the associated formation of pores, and thus increasing the raw density of the concrete, so that the desired quality and strength can be achieved. Such devices have proved very successful in practice.

During the operation of such an internal vibrator for concreting, the vibrator bottle or the hose of the internal vibrator can for example become jammed or caught in its sheath. The jam often cannot be cleared by the operator of the internal vibrator, for which reason in practice the operator sometimes has to cut off the hose of the internal vibrator, leaving the vibrator bottle behind in the concrete. The jamming of the vibrator bottle or of the hose takes place for example because the vibrator, or the vibrator bottle, deviates laterally during immersion in the concrete and becomes stuck in this cross position. Attempts on the part of the operator to recover the vibrator by pulling then cause the vibrator to become jammed in the sheath, so that it can no longer be pulled out of the concrete. The cutting off of the vibrator bottle results in high costs, because cut-off vibrator bottles must be replaced. In addition, it is undesirable to leave the cut-off vibrator bottles in the concrete, for reasons of stability.

The present invention is based on the object of indicating an internal vibrator device with which the operator is provided with support when freeing such a jamming, as well as a method for freeing a jammed internal vibrator device.

According to the present invention, the object is achieved by an internal vibrator device according to Claim 1, and by a method according to Claim 11. Preferred specific embodiments are defined in (inter alia) dependent claims, and/or are explained below in the specification.

According to the present invention, an internal vibrator device is indicated having an electric motor, a vibrator housing, an imbalance device that is situated in the vibrator housing and that can be rotationally driven by the electric motor, and a main switch for switching the electric motor on and off. In a normal operating state, the electric motor can be driven with a rotational characteristic suitable for compacting liquid concrete. The rotational characteristic of the electric motor in the normal operating state is characterized by a particular rotational speed and direction of rotation of the electric motor, as are used generally for the compacting of liquid concrete. The switching-on phase, i.e., the change over time of the rotational speed of the motor of the electric motor during switching on, is therefore not to be regarded as a normal operating state. The internal vibrator device according to the present invention comprises an operating state change device, by means of which the internal vibrator device can be operated in a liberation operating state in which the rotational characteristic of the electric motor differs from the rotational characteristic in the normal operating state.

Therefore, one aspect of the present invention is to modify the rotational characteristic of the electric motor in relation to the rotational characteristic in the normal operating state, as a result of which the following two effects are primarily achieved, as alternatives to one another or in combination. First, a jolt or shock moment is produced by an inertial movement of the motor or of the vibrator bottle and of the hose, e.g. by reversing the direction of rotation. The support of the motor stator against the shaft of the vibrator then results in the liberation of the vibrator or of the vibrator bottle from the jamming. Second, there arises a modification of the vibration

characteristics of the vibrator bottle and of the hose when passing through the resonant frequency of the vibrator bottle. Here there arises a large increase in the amplitude of the vibration of the vibrator bottle, so that the vibrator bottle vibrates excessively strongly and can easily be freed from the jammed position.

The rotational characteristic of the electric motor comprises at least one of the following parameters: direction of rotation, speed of rotation, temporal change of the speed of rotation, and temporal change of the direction of rotation. It is also possible for a plurality of these parameters to be modified in combined fashion in a suitable manner, so as to cause the greatest possible change in amplitude in the vibration of the vibrator bottle, which can liberate this bottle from the jamming. In this connection, it is also to be noted that when there is a change in the direction of rotation there arises a counter-rotation moment due to the driving of the imbalance device that is transmitted to the vibrator bottle, which also contributes to the liberation of the vibrator bottle.

Preferably, in the internal vibrator device according to the present invention the direction of rotation of the electric motor is capable of being reversed in relation to the direction of rotation in the normal operating state, by means of the operating state change device.

The operating state change device can have a rotation direction switch that can be used to predetermine the direction of rotation of the electric motor. That is, using the switch an operator can switch back and forth between different directions of rotation of the electric motor, and can liberate the vibrator bottle in this way.

In addition, it is advantageous if the internal vibrator device is capable of being operated in an automatic change-of-rotational-direction mode by means of the operating state change device, in which mode the direction of rotation of the electric motor changes automatically. In this case, the direction of rotation need not be changed manually by an operator.

In particular, it can be advantageous that the direction of rotation of the electric motor is capable

of being reversed at periodic time intervals by means of the operating state change device. That is, for example using a clock generator the direction of rotation is automatically changed at periodic time intervals. In this way, changes in vibration and vibrational states of the vibrator bottle that are suitable for the liberation of the vibrator bottle can be produced.

It can also be advantageous for the operation of the electric motor to be able to be interrupted by means of the operating state change device at periodic time intervals. Here as well, a clock generator can be used that results in the periodic interruption of the operation of the electric motor, whereby changes in vibration of the vibrator bottle suitable for liberation can be produced. The torque jolt that occurs during switching on and off also supports the freeing of the vibrator bottle.

Both for the reversal of the direction of rotation of the electric motor at periodic time intervals and also for the interruption of the operation of the electric motor at periodic time intervals, it can be advantageous for the time duration of the periodic time intervals to be able to be fixedly predetermined or to be variable. For example, it is possible that the periods in which the electric motor is operated in a particular direction of rotation are selected at first to be relatively long, and are shortened over a longer period of time. This results in very different changes of vibration and states of vibration of the vibrator bottle, resulting in a liberation of the vibrator bottle.

In addition, in the internal vibrator device according to the present invention it is advantageous if the rotational speed of the electric motor is able to be modified or controlled by means of the operating state change device. By setting the rotational speed of the electric motor to a particular value, it is possible to intentionally produce a particular vibration property or a particular vibration characteristic of the vibrator bottle, so that the vibrator bottle can be liberated. It is also possible for the modification of the rotational speed to take place automatically, i.e., for the rotational speed to be selected low at first and continually increased, so that as many different vibrational states of the vibrator bottle as possible are produced, and the vibrator bottle can be liberated.

It is also advantageous if a vibrator device comprising the vibrator housing, the electric motor, and the imbalance device can be made to pass through its natural frequency by modifying the rotational speed of the electric motor. That is, the rotational speed of the motor, or the rotational speed of the exciter, is modified in such a way that at least for a certain period of time the vibration frequency of the vibrator device corresponds to the natural frequency of the vibrator device, or is very close to it, so that there results a vibration that is sufficiently strong to liberate the jammed vibrator bottle and/or the jammed hose. When the natural frequency of the vibrator device is passed through, there results an increase in amplitude that, together with the supporting of the vibrator stator against the shaft of the vibrator, results in the liberation of the vibrator or of the vibrator bottle from the jamming.

In the method according to the present invention for freeing a jammed internal vibrator device, an imbalance device in the vibrator housing is driven by the electric motor, and in the normal operating state the electric motor is operated with a rotational characteristic in order to compact liquid concrete. Here, alternatively to operation in the normal operating state, the electric motor is operated in a liberation operating state in which the rotational characteristic of the electric motor differs from the rotational characteristic in the normal operating state.

Advantageously, in the method according to the present invention for freeing a jammed internal vibrator device, the following steps are executed individually or in arbitrary combination:

- reversal of the direction of rotation of the electric motor,
- predetermination of the direction of rotation of the electric motor,
- automatic change of the direction of rotation of the electric motor,
- reversal of the direction of rotation of the electric motor at periodic time intervals,
- interruption of the direction of rotation of the electric motor at periodic time intervals,
- modification of the rotational speed of the electric motor.

In the method according to the present invention, a vibrator device comprising the electric motor, the vibrator housing, and the imbalance device is advantageously made to pass through its natural frequency by modifying the rotational speed of the electric motor.

Another effect is to be noted here in connection with the present invention: if the vibrator bottle has become jammed, the hose is often twisted. Because as a rule the hose is made of an elastic material, for example rubber, there results a spring effect; i.e., the vibrator bottle is supported against the sheath in which it is jammed, and is held in the jammed position in this way. Through a suitable counter-rotation moment that is produced according to the present invention, the hose can be rotated still further counter to the spring action, and thus liberated. Through a jolt action produced according to the present invention in the circumferential direction of the vibrator bottle, the jamming force is overcome.

Additional features and advantages of the present invention are made clear in the following description of a preferred specific embodiment, with reference to the drawings.

Figure 1 shows a longitudinal section through a vibrator bottle of an internal vibrator device according to the present invention;

Figure 2 shows an internal vibrator device according to the present invention having an operating panel; and

Figure 3 shows diagrams that illustrate the modification according to the present invention of the rotational characteristic of the electric motor.

Figure 1 shows a known vibrator bottle 1 in which an electric motor 2 drives a first imbalance mass 3. Imbalance mass 3 forms an imbalance through which there arises a vibration of vibrator bottle 1. In the normal operating state, the electric motor drives first mass element 3 at, for example, 12,000 rotations per minute, causing vibrator bottle 1 to vibrate with approximately the

same vibrating frequency. In the normal operating state, the vibrating frequency can be different, but is selected so that the most effective compacting of the liquid concrete takes place.

Figure 2 schematically shows the overall internal vibrator device, in which vibrator bottle 1 is connected to a switch housing 6-1 via a protective and operating hose 5. On this switch housing 6-1, on an operating panel 6-2 there is provided a main switch 7 by which the normal operating state of electric motor 2 can be switched on. In addition, a rotational direction switch 8 is provided by which the direction of rotation of electric motor 2 in vibrator bottle 1 can be reversed or predetermined.

If vibrator bottle 1 becomes jammed during operation, for example in a sheath, the operator can reverse the direction of rotation of electric motor 2 via rotational direction switch 8. This results in, on the one hand, a rotational jolt, and on the other hand in a modification of the vibrational characteristic of vibrator bottle 1 and of hose 5, whereby vibrator bottle 1 and/or hose 5 can be liberated from the jamming. The reversal of the direction of rotation also results in a moment of rotation that is produced by electric motor 2 and by first mass element 3, so that a corresponding counter-rotational moment is transmitted to vibrator bottle 1 and to hose 5. This likewise results in the liberation of vibrator bottle 1 from the jamming.

In addition, on operating panel 6-2 an automatic operation switch 9 is provided for switching on an automatic liberation operating mode. If the automatic liberation operation is switched on via automatic operation switch 9, the direction of rotation of the electric motor changes automatically at periodic time intervals. Here, the time duration of the periodic time intervals can be predetermined via a period duration selection switch 10.

In the specific embodiment of the present invention shown in Figure 2, rotational direction switch 8, period duration selection switch 10, and automatic operation switch 9 are provided on operating panel 6-2. For the present invention, it is not essential that all three of these switches be present; rather, arbitrary combinations of these or additional switches can be used by which the

rotational characteristic of the electric motor can be modified in relation to the rotational characteristic in the normal operating state.

Moreover, in the switch housing a frequency transformer can be provided for producing a suitable current for electric motor 2, as is known for example from DE 92 17 854.5 U1.

Figure 3A shows a diagram illustrating the automatic reversal of the direction of rotation in automatic liberation operation. Here, via period duration selection switch 10 the time duration of a periodic time interval was set to 0.5 seconds as an example. That is, the direction of rotation changes every 0.5 seconds. It is also possible for the direction of rotation to be reversed without a time delay; i.e., the motor runs with a particular time duration in alternating fashion with one direction of rotation and with the opposite direction of rotation. Here the time duration can be predetermined.

In automatic liberation operation, the operation can also be interrupted at periodic time intervals, the time duration of a periodic time interval likewise being able to be predetermined via period duration selection switch 10.

Figure 3B shows a diagram in which the rotational operation is periodically interrupted at periodic time intervals of 0.5 seconds.

It is also possible for the time duration of a periodic time interval to be varied automatically in automatic liberation operation. This is possible both for the reversal of the direction of rotation and also for the interruption of the rotational operation of the electric motor.

Figure 3C shows a diagram in which the rotational operation is interrupted at particular time intervals, the time duration of the operation and of the interruption of the operation being continuously shortened.

In automatic liberation operation, it is also possible for the rotational speed of electric motor 2 to be controlled in an intentional manner. Here, the motor is slowly brought up to its highest speed.

Figure 3D shows a diagram in which the rotational speed is continuously increased. In the example shown in Figure 3D, the rotational speed of the motor is increased in temporally linear fashion from zero to its highest rotational speed D_{MAX} within 10 seconds. Here, at a particular point in time t_E the rotational speed achieves a value D_E at which the vibrator device vibrates with its natural frequency; i.e., the natural frequency of the vibrator device is passed through.

Additional modifications of the rotational characteristic of the electric motor are conceivable. For example, the rotational speed can be increased with time not in linear fashion but rather according to other time / rotational speed functions, e.g. step functions or exponential functions.

It is also to be noted that in the specific embodiment according to Figure 1, the electric motor 2 is situated in vibrator bottle 1. However, the present invention is also applicable if electric motor 2 is situated outside vibrator housing 1, for example in an external housing. In this case, imbalance mass 3 is for example driven via a flexible shaft provided in hose 5. In such a specific embodiment of an internal vibrator device as well, the rotational characteristic of electric motor 2 is modified as described above according to the present invention. In this case, the above-defined vibrator device comprises vibrator bottle 1 and imbalance mass 3. That is, the natural frequency of this vibrator device is passed through, which frequency assumes, under some circumstances, a different value than is the case in the above-described specific embodiment, because in the present specific embodiment electric motor 2 is situated outside vibrator bottle 1.